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Personality Effects on Cardiovascular Reactivity: Need for Closure Moderates the Impact of Task Difficulty on Engagement-related Myocardial Beta-adrenergic Activity

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Abstract

An experiment assessed the joint effect of dispositional need for closure (NFC) and task difficulty on engagement-related myocardial beta-adrenergic activity. Participants who scored either low or high on the NFC scale performed an ambiguous categorization task with either low or high difficulty. Confirming the theory-derived predictions, task difficulty effects on pre-ejection period (PEP) reactivity were moderated by NFC. If difficulty was low, PEP reactivity was low and independent of the participants' NFC level. If difficulty was high, participants with high NFC showed increased PEP reactivity compared to participants with low NFC. These results extend previous research on Wright's model of engagement-related cardiovascular reactivity and suggest that the model may provide a useful framework for assessing the impact of personality on cardiovascular response.

Keywords: need for closure, beta-adrenergic activity, sympathetic activity, pre-ejection period, task difficulty

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Integrating motivational intensity theory's predictions (Brehm & Self, 1989) with Obrist's (1981) observation that task engagement is associated with increased sympathetic impact on the heart, Wright (1996) proposed a model of engagement-related cardiovascular reactivity. According to this model, sympathetic (beta-adrenergic) impact on the heart is a direct function of task demand in active coping situations (i.e., when the individual's performance determines task outcome): The higher task demand, the higher myocardial beta-adrenergic activity. However, this relationship only holds if task success is possible and if task engagement is justified. If task success is impossible or not important enough, individuals disengage and myocardial beta-adrenergic activity is low. In the last two decades, numerous studies have tested and supported these predictions using various designs and manipulations (e.g., Gendolla & Wright, 2005, for an overview). The present study aims to demonstrate that Wright's model also provides a useful framework for understanding the impact of personality (e.g., dispositional need for closure) on engagement-related cardiovascular reactivity.

Need for closure (NFC) refers to an individual’s aversion toward ambiguity and the desire to avoid or quickly resolve it (Kruglanski & Webster, 1996). In the frame of Wright's model, NFC basically refers to the importance of success: Facing an unsolved task—an ambiguous and uncertain situation—it is more important for individuals with a high NFC to quickly solve the task and to reach closure than for low NFC individuals. According to

Wright's model, it follows that NFC should have no direct impact on myocardial beta-adrenergic activity but determine the difficulty level at which individuals disengage. Due to the high importance of successfully resolving the ambiguous situation, individuals with high NFC should invest increased effort in ambiguous tasks with high difficulty whereas individuals with low NFC should not engage in such situations.

Therefore, our predictions were twofold: 1) If task difficulty is low, individuals with low or high NFC should not differ regarding task-related myocardial beta-adrenergic activity—assessed as pre-ejection period (PEP) reactivity. Myocardial beta-adrenergic activity should be low due to the low task demand. 2) If task difficulty is high, low NFC individuals should perceive task success as not important enough to justify task engagement and should disengage. Correspondingly, they should show low beta-adrenergic activity. Individuals with high NFC should see task engagement as justified and engage in the task. Due to the high task difficulty, myocardial beta-adrenergic activity should be high.

Method

Participants and Design

One hundred forty-eight psychology students completed the revised NFC scale (Roets & Van Hiel, 2007; original version by Webster & Kruglanski, 1994). The mean NFC total score was 157.09 (SE = 1.64, range: 94-215). Fifty-four participants scoring either in the lower (total score < 146, *low NFC group*) or the upper quartile (total score > 171, *high NFC group*) participated at a second session and were randomly assigned to a *low* or a *high* task difficulty condition.[1] Participation was voluntary and data treatment was anonymous. Respondents participated for course credit.

Opmerking [a1]: In?

Apparatus and Physiological Measures

A Vasotrac APM 205A blood pressure monitor (Medwave, Arden Hills, MN) assessed systolic (SBP) and diastolic blood pressure (DBP) (all in millimeters of mercury [mmHg]). A modified CardioScreen 1000 impedance cardiograph (medis, Illmenau, Germany) collected electrocardiographic and thoracic impedance data at a sampling rate of 1000 Hz.

Categorization Task

We employed a slightly modified version of a categorization task that has been successfully employed in research on NFC effects on behavior (e.g., Roets & Van Hiel, 2008). Participants were presented with target figures which they had to allocate to category “A” or category “B” by pressing the corresponding keys. They immediately received feedback on the correctness of their response allowing them to discover the correct allocation rule by trial-and-error. The task consisted of 27 trials, each presenting the following four screens: 1) a fixation cross (500 milliseconds), 2) the target (displayed for maximally 4000 milliseconds), 3) performance feedback (at least 1000 milliseconds, duration was automatically adapted so that the total duration of target and feedback was exactly 5000 milliseconds), 4) a blank screen (1000 milliseconds).[2] Targets were figures composed of different types of symbols (squares, hearts, or smilies) printed in different colors (red, blue, or yellow) and varying in the number of presented symbols (one, two, or three). Thus, one given figure showed between one and three squares, hearts, or smilies painted in red, blue, or yellow. All possible combinations were presented in random order.

In the *easy task* condition, the categorization rule depended only on one dimension of the figure: “If figure is blue, then category A, else category B”. In the *difficult task* condition, the categorization rule relied on two dimensions: “If figure is blue AND number of symbols is three, then category A, else category B”. Given that most students are not familiar with such a task, participants first performed a practice run of the task with a categorization rule that was different from the actual assignment but identical in difficulty (i.e., the categorization rule was either easy in both the practice and task trials or difficult in both runs). The practice trials allowed participants to familiarize themselves with the task and to learn about its difficulty. Cardiovascular measures were not assessed during practice.

Procedure

Students participated individually in the experiment. Having applied the blood pressure cuff and the CardioScreen electrodes, the experimenter started the computer software and left the room. After indicating their age, gender, and major field of study, participants learned about the categorization task and the trial-and-error strategy. They saw the 27 figures and an example on how the figures could be grouped using categorization rules.

Participants performed the practice trials during which all twenty-seven possible figures were presented in random order. After practice, the experimenter instructed the participants to sit as calmly as possible during the following habituation period. The habituation period lasted eight minutes and the participants could leaf through some magazines while cardiovascular measures were taken. Then, participants performed again the 27 trials of the categorization task presented in random order while cardiovascular measures were collected. Finally, participants were debriefed, probed for suspicion, and received course credit.

Data Scoring, Reduction, and Analysis

The dZ/dt signal was ensemble-averaged over periods of 60 seconds and two independent raters scored PEP values (in milliseconds, computed as the interval between R-onset and B-point) for each average. Since the inter-rater agreement was good (ICC[2,1] = 0.86), the arithmetic mean of both raters' PEP values was used for the statistical analyses.

Heart rate (HR, in beats per minute) was determined by counting the r-peaks of the electrocardiographic signal. The arithmetic means of all data collected during the last three minutes of the baseline period (Cronbach's αs > .96) constituted our baseline scores. The arithmetic means of the data obtained during the three minutes of task performance constituted the task scores (Cronbach's αs > .96). Reactivity scores were computed for each participant and each cardiovascular measure by subtracting baseline scores from task scores.[3]

Given that our specific theory-driven predictions about the joint impact of NFC and task difficulty on cardiovascular reactivity lead to a pattern that is not adequately captured by the tests of a conventional 2 x 2 ANOVA, a specific contrast tested our main hypothesis. Contrast weights were +3 in the difficult-high-NFC cell and -1 in the other three cells. Two (task difficulty) x 2 (NFC group) between-persons ANOVAs were employed to analyze cardiovascular baseline scores.

Results

Cardiovascular Reactivity

PEP Reactivity. The planned contrast was significant, $F(1, 46) = 9.21$, $p = .004$, $MSE = 10.70$, $\eta_p^2 = 0.17$ (residual $F = 0.32$). Pairwise comparisons indicated significantly higher PEP reactivity in the difficult-high-NFC cell compared to the difficult-low-NFC cell, $F(1, 46) = 7.31$, $p = .01$. Both easy cells did not differ from one another, $F(1, 46) = 0.33$, $p = .57$. Furthermore, PEP reactivity significantly increased from the easy-high-NFC cell to the difficult-high-NFC cell, $F(1, 46) = 7.12$, $p = .01$. Figure 1 displays the PEP reactivity pattern.

HR, SBP, and DBP Reactivity. The planned contrast was significant for HR reactivity scores, $F(1, 46) = 6.89$, $p = .01$, $MSE = 10.38$, $\eta_p^2 = 0.13$ (residual $F = 0.23$). Furthermore, HR reactivity significantly increased from the easy-high-NFC cell to the difficult-high-NFC cell, $F(1, 46) = 6.84$, $p = .01$. The difference between NFC groups was not significant within the easy condition (p = .56) but approached significance within the difficult condition (p = .07). The planned contrast did not reveal significant effects on SBP reactivity, $F(1,46) = 0.30$, $p = .58$, $MSE = 20.67$, and DBP reactivity, $F(1, 46) = 0.40$, $p = .53$, $MSE = 8.70$.[4]

Cardiovascular Baselines

There were no significant effects of NFC, task difficulty, or their interaction on SBP, DBP, HR, and PEP baseline scores (all ps > .13). Baseline scores were not significantly associated with their respective reactivity scores, -.22 < rs < -.02, ps > .12. Table 1 displays cell means and standard errors of all cardiovascular baseline and reactivity scores.

Discussion

The presented results support our hypothesis regarding the moderating impact of NFC on engagement-related myocardial sympathetic response. If task difficulty was low, PEP reactivity—a non-invasive indicator of beta-adrenergic impact on the heart—was low and did not differ between low and high NFC participants. If task difficulty was high, PEP reactivity was high in the high NFC group and low in the low NFC group. Given that PEP changes were not accompanied by decreases in HR or DBP, it is unlikely that the observed changes in PEP were due to changes in cardiac preload or afterload and the PEP reactivity pattern that we found can be attributed to changes in myocardial sympathetic activity (Sherwood et al., 1990).

HR reactivity mirrored the PEP reactivity pattern, whereas SBP and DBP reactivity did not. This lack of blood pressure effects may seem surprising given that preceding research on Wright's model has often found effects on SBP reactivity as well (e.g., Gendolla & Wright, 2005). However, PEP reactivity is the most sensitive to changes in myocardial sympathetic activity. Given that blood pressure is a function of heart rate, myocardial contractility, and total peripheral resistance, sympathetic effects on blood pressure may have been masked by counteracting changes in total peripheral resistance. Our sample size may offer another explanation for the lack of significant effects on blood pressure reactivity. The sample size of our study has been determined drawing on preceding research on Wright's model (e.g., Wright, Killebrew, & Pimpalapure, 2002) and on need for closure (e.g., Roets & Van Hiel, 2008) that has used comparable sample sizes. However, some of the non-significant group differences that were visible on the descriptive level (i.e., the increase in SBP and DBP reactivity with task difficulty among high NFC participants) would probably have reached significance in a larger sample.

Opmerking [a2]: Had?

The obtained effects on PEP –the central and most sensitive measure- as well as the effects on HR demonstrate that dispositional NFC does not exert a direct impact on task engagement. NFC only sets the upper limit of the relationship between task difficulty and cardiovascular reactivity. The level of dispositional NFC thus determines whether or not an individual disengages under high task difficulty. However, it should be noted that NFC refers to the importance of resolving ambiguity. Hence, these NFC effects on engagement-related cardiovascular response should only appear if the task situation confronts the individual with an ambiguous situation. Moreover, if resolving ambiguity can be successfully achieved regardless of the correctness of the response, high NFC individuals may just quickly settle for any solution (see, Roets, Van Hiel, Cornelis, & Soetens, 2008).

Opmerking [a3]: The inserted explanation regarding the sample size above somewhat disrupts the flow of the paper. Here I just tried to make a clear 'return' to the core finding and message of our study. If you want to make changes to further improve this, please do.

Most importantly, our study completes two studies by Roets and van Hiel (2008) that examined the impact of NFC on various physiological measures and observed that individuals with a high NFC show increased SBP, HR, and skin conductance responses in decision-making tasks. In contrast to this preceding research, the design of our study allowed to specifically test the predictions derived from Wright's model. Furthermore, by assessing PEP we were able to directly examine sympathetic impact on the heart—the central dependent variable in Wright's model.

The presented study demonstrates that, because high dispositional NFC increases the importance of resolving ambiguous tasks for the individual, it justifies engagement—operationalized as cardiovascular activity—when difficulty increases, whereas low NFC does not. [[[This result suggests that Wright's model of engagement-related cardiovascular responses may offer a useful framework for assessing the effects of personality factors on cardiovascular response. At least some personality factors may—like dispositional need for closure—not affect task engagement in a linear way but determine when individuals disengage. However, more research is needed to examine if the effects that we have found for dispositional need for closure can be generalized to other personality factors.]]]

Opmerking [a4]: Below is a reworded version of these last lines. I feel it now has a slightly more positive tone to it. What do you think? Feel free to change it or keep the original.

Of interest for future research, the finding that dispositional need for closure does not affect task engagement in a linear way but determines when individuals disengage, might be generalized to other personality variables. As such, Wright's model of engagement-related cardiovascular responses may offer a useful, general framework to investigate the effects of personality factors on cardiovascular response in future research.

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Footnotes

[1] The data of four participants could not be used due to poor signal quality. The data of the remaining 50 participants was used in the statistical analysis. The distribution of women and men was balanced across the conditions.

[2] If a participant did not press a key while the target was displayed, a message reminding the participant to press a key was displayed instead of the feedback.

[3] For more details about measurement devices and preprocessing of physiological data, see Richter, Friedrich, and Gendolla (2008).

[4] Analyzing HR, SBP, and DBP reactivity with conventional 2 (task difficulty) x 2 (NFC group) between-persons ANOVAs did only reveal a significant interaction on DBP reactivity, $F(1, 46) = 4.81$, $p = .03$ (all other ps > .10).

Table 1

Arithmetic Means and Standard Errors of Cardiovascular Baseline and Reactivity Scores

	PEP	HR	SBP	DBP
		Baseline scores		
easy – low NFC	93.10 (2.64)	82.00 (3.70)	121.90 (3.06)	67.53 (2.12)
easy – high NFC	100.65 (2.21)	80.95 (2.34)	123.50 (4.24)	70.17 (2.29)
difficult – low NFC	99.57 (2.95)	76.57 (2.04)	126.05 (3.24)	70.93 (2.45)
difficult – high NFC	98.57 (3.20)	77.19 (3.58)	119.29 (5.11)	69.46 (3.92)
		Reactivity scores		
easy – low NFC	-2.08 (0.69)	1.49 (0.86)	5.01 (1.05)	3.12 (0.63)
easy – high NFC	-1.38 (1.08)	0.76 (0.94)	0.95 (1.54)	0.60 (0.91)
difficult – low NFC	-1.14 (0.87)	1.54 (1.04)	3.82 (1.72)	0.96 (1.05)
difficult – high NFC	-4.62 (0.98)	3.90 (0.83)	4.04 (0.76)	2.14 (0.74)

Note. PEP is in milliseconds, HR is in beats per minute, and SBP and DBP are in millimeters of mercury. N = 14 in the difficult-high-NFC cell, n = 12 in all other cells.

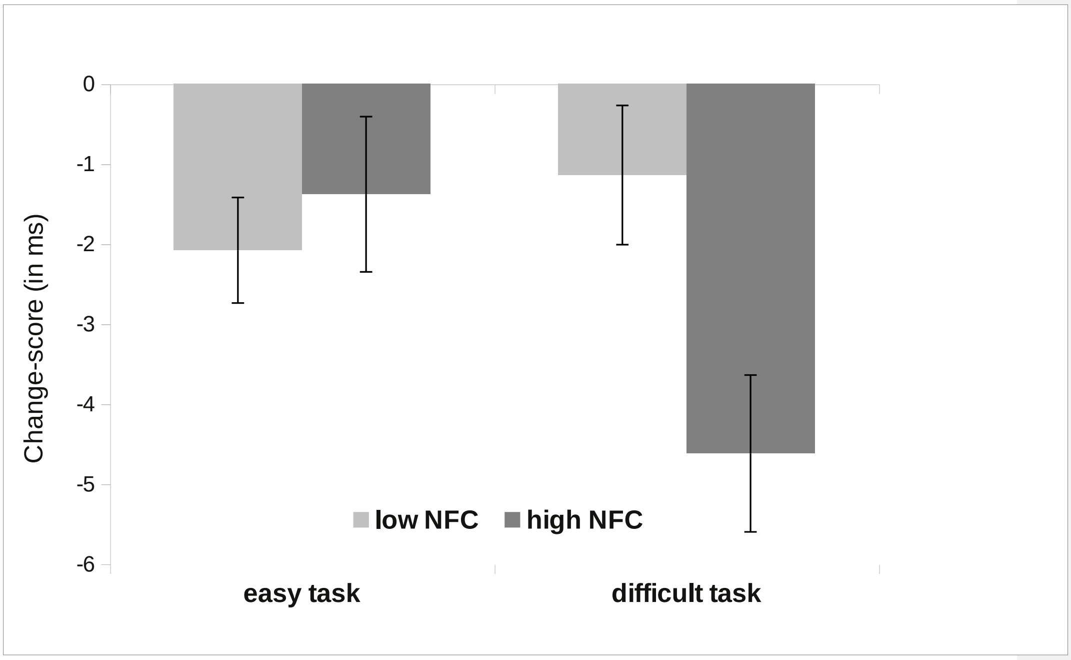

Figure 1. PEP reactivity (in ms) during task performance. Error bars represent standard errors.